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# *Quadracaea mediterranea*, a new record from Kumaun Himalaya region, India

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Abstract—*Quadracaea mediterranea* was collected during our continuing mycological survey of saprobic conidial fungi on decaying leaf litter of *Quercus floribunda* from the Ramgarh forest, Nainital, Uttarakhand, India. Detailed taxonomic information on *Q. mediterranea* includes morphological description, geographical distribution, comments, illustrations, and a comparison with allied taxa. This finding extends the geographic distribution of the species, previously recorded only in China, Italy, and Brazil.

Key words—anamorphic fungi, cellotape technique, hyphomycetes, plant debris, saprobic

## Introduction

*Quadracaea* was established by Lunghini & al. (1996), for a single species, *Q. mediterranea*. Subsequently, two additional species were described, *Q. roureae* Y.D. Zhang & X.G. Zhang and *Q. stauroconidia* F.R. Barbosa & Gusmão (Zhang & al. 2012, Barbosa & al. 2013). *Quadracaea* species are characterized by macronematous mononematous straight thick-walled septate conidiophores, integrated terminal and intercalary polyblastic conidiogenous cells producing groups of ampulliform separating cells, blastic solitary conidia, each bearing a frill at the base, with rhexolytic conidial secession, and occurrence of a synanamorph (Lunghini & al. 1996, Zhang & al. 2012, Barbosa & al. 2013). Conidiophore branching and size, conidial shape, and presence of lateral cells are important diagnostic characters for *Quadracaea* spp. The species are thought to be saprophytic and have been discovered on rotten wood, branches, twigs, bark, and leaves of various trees and shrubs or on decaying herbaceous materials in both freshwater and terrestrial habitats.

Based on the presence of a synanamorph and rhexolytical conidial secession, *Uberispora* Piroz. & Hodges and *Physalidiopsis* R.F. Castañeda & W.B. Kendr. are considered to be the closest related genera to *Quadracaea* (Pirozynski & Hodges 1973, Castañeda-Ruiz & Kendrick 1990). However, *Uberispora* does not produce separating cells and displays a different arrangement of satellite cells around the central conidial cell (Pirozynski & Hodges 1973, Castañeda-Ruiz & al. 1996). *Physalidiopsis* differs from *Quadracaea* primarily by producing short branches on the conidiophores (Castañeda-Ruiz & Kendrick 1990). The presence of stauroconidia in *Physalidiopsis* was used as a major character by Lunghini & al. (1996) to distinguish it from *Quadracaea*.

Knowledge on the occurrence and diversity of *Quadracaea* is limited. During ongoing surveys of saprobic microfungi from Ramgarh forest, Nainital, Uttarakhand, India, an interesting anamorphic fungus was collected from leaf litter. This fungus was identified as *Quadracaea mediterranea* and is described and illustrated as a new record for India.

## Materials & methods

Samples of plant debris including leaves, twigs and bark were collected at random from different parts of Ramgarh forest of Nainital (29°26′49″N 79°33′35″E), Uttarakhand, India, during the winter months (January–February) of 2013, placed in plastic bags and transported to the laboratory. The plant materials were incubated in moist chambers at 25°C and examined with a stereomicroscope, over a two-week period, for the presence of dematiaceous hyphomycetes. When interesting fungi were seen, slides were prepared using a cellotape technique as described by Dubey & al. (2018, 2019). All microscopic characteristics were examined, measured, and photographed using light microscopy.

A microscope slide containing the reproductive structures of *Quadracaea*, which was found on decaying leaves of *Quercus floribunda*, was deposited in the Herbarium of the Indian Agricultural Research Institute, New Delhi, India (IARI).

## Taxonomy

***Quadracaea mediterranea*** Lunghini, Pinzari & Zucconi,
Mycotaxon 60: 104, 1996. FIG. 1

COLONIES on natural substratum amphigenous, irregularly effuse, dark brown to blackish, hairy, loosely dispersed often producing only scattered

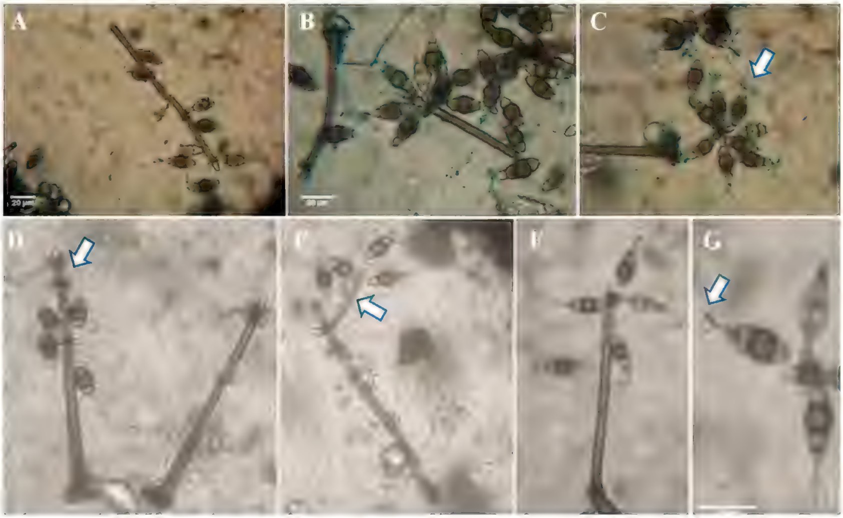

Fig. 1. *Quadracaea mediterranea* (IARI HCIO 52003) from oak leaf litter. A, B. Conidia attached to conidiophore; C. Conidia with darker central cells and phialoconidia (arrow); D. Details of the ampulliform separating cells (arrow); E. Proliferating separating cells (arrow); F. Conidia attached to conidiophore via separating cells; G. Conidia with apical synanamorphic phialoconidia (arrow).

conidiophores with a dark lobate base. Mycelium partly immersed and partly superficial in the substratum; hyphae branched, septate, smooth-walled, light brown to yellowish brown, 2–5 µm diam. Conidiophores mononematous, macronematous, simple, erect, 5–(6)–8 septate (septa thin), cylindrical, usually solitary or in groups of two or four, mid to dark yellowish brown, mainly subhyaline or paler towards the apex, smooth, thick-walled, 82–(130)–150 µm long, 8–10 µm diam. at the lobate base, 6–8 µm diam. in the middle, tapering gradually towards the rounded apex, sometimes with percurrent regenerations. Conidiogenous cells polyblastic, sympodial, concolorous with the separating cells, more or less sub-cylindrical or cylindrical, 6–9 µm long, 3–6 µm diam., integrated into the apical region of conidiophores, terminal but becoming intercalary by percurrent proliferations which arise by extension of the basal septum of the apical/terminal separating cell into and beyond it. Separating cells in clusters (≤10) or single, thin-walled, smooth, 4–8 µm long, 1.5–3.0 µm diam., concolorous with the conidiophore, ampulliform, usually tapered at the apex, empty, leaving an open end after rhexolytic conidial secession (Fig. 1D); sometimes it may proliferate percurrently at the tip growing through the scar of the fallen conidium to produce a lateral branch, growing for a length of up to 25–40 µm before producing more conidia (Fig. 1E). Conidia produced singly, acropleurogenous, versicolored, suboval or obpyriform to broadly-fusiform or lemoniform, with 3 transverse septa, smooth, dry, 20–(26)–30 µm long, 8–(10)–12 µm thick at the broadest point, sometimes slightly constricted at septa; second cell broadest, fusoid, largest, thick-walled with most conspicuous broad black bands at the septa, darker than the others; third or penultimate cells dark to pale brown, smaller, and thick-walled; apical cell hyaline to subhyaline, smallest, thin-walled, narrowly conical with pointed apex, bearing 2–4 conspicuous, prominent subconical elongations producing phialoconidia, each up to 5–8 µm long and 0.6–1.5 µm diam. (Fig. 1F, G). Basal cell small, slightly thick-walled, funnel-shaped, smooth, pale brown or subhyaline, bearing a conspicuous frill at the base. Synanamorphic phialoconidia blastic, hyaline, smooth, thin-walled, aseptate, fusiform, slightly falcate and produced apically in a *Selenosporella*-like manner.

Specimen examined: **INDIA, Uttarakhand, Nainital**, Ramgarh forest, on decaying leaves of *Quercus floribunda* Lindl. ex A. Camus (*Fagaceae*), 16 January 2013, coll. Gupta BKU 122 (IARI HCIO 52003).

Distribution: Brazil (Santa Izabel & Gusmão 2018), China (Wu & Zhuang 2005), Italy (Lunghini & al. 1996), India (this report).

Comments: Our specimen represents the first record of this species for India. The Indian specimen closely matches the original description of *Q. mediterranea* (Lunghini & al. 1996), except that our Indian material had proliferating separating cells, slightly larger conidia, and smaller conidiophores.

*Quadracaea mediterranea* is easily distinguished from other species of the genus by its distinct conidiophores and conidial morphology. *Quadracaea roureae* and *Q. stauroconidia* have branched conidiophores and conidia without lateral cells. The conidia of the former usually contain up to 2 lateral cells whereas in later the conidia comprises mainly 2 (or rarely 1) lateral cells. The conidia of *Q. roureae* are predominantly obpyriform, while *Q. stauroconidia* produces stauriform conidia with one dark, angular central cell and satellite cells around it (Barbosa & al. 2013). *Quadracaea mediterranea* has been reported on leaf litter of *Quercus ilex* L. (Lunghini & al. 1996) and decaying leaves of unidentified plants (Wu & Zhuang 2005, Santa Izabel & Gusmão 2018). *Quadracaea roureae* has been found on dead branches of *Rourea minor* (Gaertn.) Alston (*Connaraceae*; Zhang & al. 2012) and *Q. stauroconidia* on submerged leaves/twigs of tropical plants (Barbosa & al. 2013). This record of *Q. mediterranea* in the high altitude of India's Central

Himalayas extends its geographic distribution and emphasizes the ecological importance of the Kumaun Himalaya region as an important center for conservation of rare fungal species.

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